BATTERY THERMAL MANAGEMENT METHOD AND SYSTEM

[0001] CROSS-REFERENCE TO RELATED APPLICATION(S)

[0002] This application claims the benefit under 35 USC §119(a) of Indian Patent Application No. 3838/CHE/2015, filed on Jul. 27, 2015, in the Indian Patent Office, the entire disclosure of which is incorporated herein by reference for all purposes.

BACKGROUND

[0003] 1. Field

[0004] The following description relates to a battery thermal management method and system.

[0005] 2. Description of Related Art

[0006] Lithium ion (Li-ion) batteries provide an option of low weight, high energy density, and slow discharge rates, as compared to other battery technologies. These advantages of the Li-ion batteries, has made them desirable for high energy demanding applications such as electric vehicles. The energy held by lithium-ion cells is multiple times than that of conventional lead acid or nickel cadmium batteries. However, a lithium-ion battery has an inherent problem of overheating leading to thermal runaway. Li-ion battery degrades faster at high temperatures and offers low capacity at low temperature. At very high temperature, the thermal runaway may be triggered in the Li-ion battery due to unwanted exothermic reactions in organic electrolytes. The Li-ion battery typically works best in a narrow band of temperature close to human comfort zone and typically elaborate thermal management systems are used in order to maintain the operating temperature in that band. Thus thermal management may enable maintenance of battery performance, improved battery life, and addresses safety concerns.

[0007] Such typical thermal management approaches implement feedback controlled thermal management, i.e. only after a measured temperature of a battery or battery pack exceeds a set threshold, a cooling system is actuated to cool the batteries or the battery pack to below the threshold. However, due to the inherent dependence of the battery electrochemical processes on temperature and the resulting delay before the battery cooling operation is implemented, this typical approach results in higher heat dissipation and inefficient operation. Further, such existing approaches for thermal management do not consider alternate features for thermal management, hence they mostly fail to provide accurate control over operating temperature of the battery.

[0008] For example, as noted, in general the thermal management of large battery pack is primarily done through feedback control. However, the heat generation in the battery pack is strongly related to State of Charge (SoC) of the batteries and the discharge rate. Thus, existing feedback control based thermal management approaches fail to provide efficient cooling as they do not predict heat generation by the batteries. This may results in overheating or overcooling of the battery and may lead to hazardous situations.

SUMMARY

[0009] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[0010] One or more embodiments herein provide a method and a battery system providing thermal management for a battery based on a predictive control mechanism. One or more embodiments herein also provide a method for predicting total heat generation in the battery, based on internal conditions of the battery, wherein the internal conditions include at least one of a State of Charge (SoC) of the battery, a load current drawn by a load connected to the battery and a current temperature of the battery.

[0011] One or more embodiments herein provide a method for initiating a thermal cycle of a thermal cycle unit in the battery system to maintain an operating temperature of the battery to a select target temperature or temperature range for the battery.

[0012] One or more embodiments herein provide a method and system for computing a power for the thermal cycle unit to initiate the thermal cycle that maintains the operating temperature at the target temperature.

[0013] In one general aspect, a method for thermal management of a battery system includes predicting a total heat generation by a battery based on determined internal conditions of the battery, and controlling a selective adjusting of a heat transfer coefficient for the battery based on the predicted total heat generation to maintain an operating temperature of the battery at a target temperature or within a target temperature range.

[0014] The determined internal conditions may include at least one of a state of charge (SoC) of the battery, a load current supplied by the battery to a load connected to the battery, and a present operating temperature of the battery.

[0015] The controlling of the selective adjusting of the heat transfer coefficient may include controlling a thermal cycle of a thermal cycle unit to increase or decrease the heat transfer coefficient for the battery to maintain the operating temperature of the battery at the target temperature or within the target temperature range. The determined internal conditions may be at least one of a state of charge (SoC) of the battery, a load current supplied by the battery to a load connected to the battery, and a present operating temperature of the battery.

[0016] The controlling of the thermal cycle of the thermal cycle unit may include calculating a target heat transfer coefficient for the battery based on a heat transfer difference that depends on the predicted total heat generation, calculating a power required by the thermal cycle unit for the thermal cycle to increase or decrease the heat transfer coefficient of the battery to match the target heat transfer coefficient to maintain the operating temperature of the battery at the target temperature or within the target temperature range, and controlling the thermal cycle unit at the calculated power. The heat transfer difference that depends on the predicted total heat generation may be defined by a plurality of parameters including the predicted total heat generation, an area of heat transfer in the battery, the target temperature or target temperature range, a control time interval for the battery, the present operating temperature of the battery, a present temperature of a controlling element used by the thermal cycle unit to implement the thermal cycle.

[0017] The target temperature or target temperature range may be dependent on a user set operating mode of the battery, from among an operating mode for longer battery